

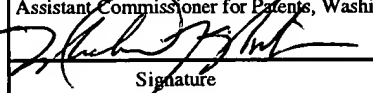
PATENT APPLICATION
Attorney Docket No. D/97063

APPLICATION FOR
UNITED STATES LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

Be it known that I, Stephen F. Linder, a citizen of the United States of America,
residing in the State of New York, have invented:

A METHOD AND SYSTEM FOR PROCESSING AND RENDERING
OBJECT ORIENTED NEUTRAL IMAGE DATA

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TITLE OF THE PRESENT INVENTION

**A METHOD AND SYSTEM FOR PROCESSING AND RENDERING
OBJECT ORIENTED NEUTRAL IMAGE DATA**

FIELD OF THE PRESENT INVENTION

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The present invention relates to the processing and rendering of object oriented image data in a digital color printing or reproduction system. More specifically, the present invention relates to the processing and rendering of object oriented neutral image data separately from the non-neutral image data and based upon the object type and object sub-type classification of the image data.

20

BACKGROUND OF THE PRESENT INVENTION

25

The use of color in the digital environment has created problems for color printers trying to produce satisfactory results. One problem facing color printers stems from the proliferation of desktop publishing software programs or applications.

The problem with these desktop publishing systems is that the systems allow the user to combine different types of objects into a composite document. For example, a user can combine photographic images, text, and business graphics (charts) into a single document
5 wherein these images may be either color or black/white.

To achieve satisfactory results each of these objects need to processed differently so that the high quality document can be produced. For example, let assume that a digital color system is trying to render a composite document with a photographic image and a
10 business graphic. In order to achieve high quality rendering of a photographic image, the color system may have to skew the color attributes in a certain way, but this skewing may cause the business graphics in the same composite document to appear washed out. On the other hand, if the color printing system is skewed to ensure
15 saturated vivid colors for the business graphics, the photographic image in the composite document may lose its life-like appearance. 2.

To resolve this problem, object oriented rendering systems have been developed. In such conventional systems, the objects which make up a composite document are rendered (processed) uniquely.

20 In other words, a photographic object or ^{bitmap} image will be processed one way, while business graphics will be processed another way. In this way, an object can be rendered to optimize its quality.

Furthermore, the neutral rendering requirements for different object types may vary. More specifically, neutral rendering refers to
25 the appearance of black, greys, and white on a printed page or output device. This rendering may be understood in terms of process (multi-

a color) or true (single ^{component} or no color) neutrals. Table 1 below provides an illustration as to how neutral rendering may vary from object to object.

Table 1

OBJECT	BLACKS	GREYS	WHITES
Bitmap	Process Black	Process black	Does not have to be Paper White
Graphic	Single Component Black	Single Component Black	Paper White
Text	Single Component Black	Single Component Black	Paper White
Photographic	Process Black	Process Black	Does not have to be Paper White

5 As illustrated in Table 1, process blacks and greys may be acceptable for ^{bitmap} ~~photographic~~ objects since true blacks or greys may introduce unwanted gloss differences. On the other hand, true blacks or greys are desired for black lines within a graphic object so as to reduce misregistration and imperfect color balance artifacts. Thus, an object may need to have its neutral image rendered in a manner different from the rendering of the non-neutral image. These diverse requirements cause problems when rendering objects in a composite image.

15 One example of this problem is the presence of an appreciable gloss differential when black text is to be rendered within a business

graphic object. One conventional solution is to have the object rendered utilizing all of the primary colors resulting in the black text being rendered using process black (cyan, magenta, and yellow). By rendering the text with process black, the text will have the appearance of having a high gloss which is not necessarily desirable from a user's standpoint. Most user prefer a low gloss for text which cannot be realized with process black. Another possible conventional solution, from the standpoint of the obtaining neutrals, is the utilization of a 100% under color removal (UCR) strategy. However, this strategy may reduce the chroma of shadow regions and suffer from other color fidelity problems.

Another example of this problem is white point shifts caused by expert color control color adjustments, which allow for user control of various color attributes, such as lightness, contrast, chroma, and color balance. White point shifts are desirable for ^{bitmap} some objects since these types of shifts occur in natural scenes; however, in graphic and text objects, it is desirable to have the expert color control adjustment leave the white points unaltered and unshifted since white points shifting in graphic and text objects create undesirable artifacts.

Not only ^{do} ~~does~~ various objects require different neutral rendering processes, but the neutral items within an object may each require unique rendering processes. For example, an object may be classified as a graphic object. Moreover, this graphic object type may include a black line and/or fill. Although black lines and fills share many common rendering characteristics as members of the graphic object, black lines and fills differ with respect to neutral rendering.

More specifically, black lines should be rendered as single component black rather than process black to reduce misregistration and imperfect color balance artifacts. On the other hand, black fills should be rendered as process black rather than single component black in order to reduce differential gloss effects that may be evident in color and black sweeps and to reduce black fill dropouts due to gloss differences with filled color areas.

Therefore, it is desirable to utilize an object oriented processing and rendering system which allows for object oriented neutral rendering and provide a framework for features that effect neutral rendering. Moreover, it is desirable to have an object oriented neutral processing and rendering system which optimizes the rendering of neutral colors based upon partitioning of objects and of types which can be further optimized by partitioning each object type into object sub-types. In other words, it is desirable to have a processing and rendering system which allows for common rendering characteristics to be identified by the object type and rendering fine tuning to be performed based upon the object sub-type.

SUMMARY OF THE PRESENT INVENTION

One aspect of the present invention is a system for processing object oriented image data. This system includes a first parser circuit to parse the object oriented image data into non-neutral color image data and neutral color image data, a second parser circuit to parse the neutral color image data into black color image data, grey color image, and white color image data, and a neutral color processing circuit to

process the black color image data, grey color image data, and the white color image data.

Another aspect of the present invention is a method for processing object oriented image data. This method parses the object oriented image data into non-neutral color image data and neutral color image data, parses the neutral color image data into black color image data, grey color image data, and white color image data, processes the black color image data, the grey color image data, and the white color image data; and processes the process black color image data, process grey color image data, the process white color image data, and the non-neutral color image data.

A third ^{aspect} is a system for processing object oriented image data. The system includes parsing means for parsing the object oriented image data into non-neutral image data and neutral image data; neutral rendering transform means for transforming a color and a colorspace of the neutral image data; and image processing means for processing the transformed neutral image data and the parsed non-neutral image data.

Further objects and advantages of the present invention will become apparent from the following descriptions of the various embodiments and characteristic features of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The following is a brief description of each drawing used to describe the present invention, and thus, are being presented for

illustrative purpose only and should not be limitative of the scope of the present invention, wherein:

Figure 1 illustrates a block diagram of a typical xerographic color rendering system;

5 Figure 2 shows a block diagram illustrating a system for rendering object oriented image data according to the concepts of the present invention;

10 Figure 3 is a flowchart illustrating a process for rendering object oriented image data according to the concepts of the present invention;

Figure 4 shows a block diagram illustrating a system for processing object oriented image data according to the concepts of the present invention;

15 Figure 5 show a flowchart illustrating the processing of object oriented image data according to the concepts of the present invention;

~~Figure 6 shows a flowchart illustrating the rendering of object-oriented image data according to the concepts of the present invention;~~

20 Figure ~~7~~⁶ shows block diagram illustrating a system for processing object oriented image data according to the concepts of the present invention; and

Figure ~~8~~⁷ is a block diagram showing a conventional object oriented rendering system.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The following will be a detailed description of the drawings illustrated in the present invention. In this description, as well as in the
5 drawings, like reference numerals represent like devices, circuits, or equivalent circuits which perform the equivalent functions.

As noted above, the present invention is directed to object oriented printing or rendering. The actual rendering process can be carried by a variety of rendering processes, such as laser xerography,
10 inkjet, etc. For the sake of brevity, a laser xerographic system will be described below with respect to the present invention.

In the laser xerographic printing process, an electrostatic charge pattern or latent image corresponding to an original is formed on an insulating medium. A viewable record is then produced by developing
15 the latent image with particles of granulated material to form a powder image thereof. Thereafter, the visible powder image is fused to the insulating medium, or transferred to a suitable support material and fused thereto. Development of the latent image is achieved by bringing a developer mix into contact therewith. Typical developer
20 mixes generally comprise dyed or colored thermoplastic particles of granulated material known in the art as toner particles, which are mixed with carrier granules, such as ferromagnetic granules. When appropriate, toner particles are mixed with carrier granules and the toner particles are charged triboelectrically to the correct polarity. As
25 the developer mix is brought into contact with the electrostatic latent image, the toner particles adhere thereto. However, as toner particles

are depleted from the developer mix, additional toner particles must be supplied.

An example of an electrostatic digital color copier is shown in Figure 1. Figure 1 is a schematic elevational view showing an exemplary electrophotographic printing/copying machine and a networked PC. An ESS (electronic subsystem) or image processing station (both referred to as IPS), indicated generally by the reference numeral 12, contains data processing and controller electronics which prepare and manage the image data flow to a raster output scanner (ROS) indicated generally by the reference numeral 16. A network of one or more personal computers (PC), indicated generally by the reference numeral 5, is shown interfacing with or in communication with IPS 12. A user interface (UI), indicated generally by the reference numeral 14, is also in communication with IPS 12.

UI 14 enables an operator to control and monitor various operator adjustable functions and maintenance activities. The operator actuates the appropriate keys of UI 14 to adjust the parameters of the copy. UI 14 may be a touch screen, or any other suitable control panel, providing an operator interface with the system. The output signal from UI 14 is transmitted to IPS 12. UI 14 may also display electronic documents on a display screen (not shown in Figure 1), as well as carry out the image rendering selections.

As further shown in Figure 1, a multiple color original document 38 may be positioned on (optional) ^{step 121 on} raster input scanner (RIS), indicated generally by the reference numeral 10. The RIS contains document illumination lamps, optics, a mechanical scanning drive,

and a charge coupled device (CCD array) or full width color scanning array. RIS 10 captures the entire image from original document 38 and converts it to a series of raster scan lines and moreover measures a set of primary color densities, i.e., red, green and blue densities, at each point of the original document. RIS 10 may provide data on the scanned image to IPS 12, indirectly to PC 5 and/or directly to PC 5.

Documents in digital or other forms may be created, screened, modified, stored and/or otherwise processed by PC 5 prior to transmission/relay to IPS 12 for printing on printer 18. The display of PC 5 may show electronic documents on a screen (not shown in Figure 1). IPS 12 may include the processor(s) and controller(s) (not shown in Figure 1) required to perform the adaptive image rendering system of the present invention.

IPS 12 also may transmit signals corresponding to the desired electronic or scanned image to ROS 16, which creates the output copy image. ROS 16 includes a laser with rotating polygon mirror blocks. The ROS illuminates, via mirror 37, the charged portion of a photoconductive belt 20 of a printer or marking engine, indicated generally by the reference numeral 18, at a predetermined rate of MXN pixels per inch, to achieve a set of subtractive primary latent images. MXN may represent 400 X 400 dpi (dots per inch), 600 X 600 dpi, or even asymmetrical resolutions, such as 300 X1200 dpi.

The ROS will expose the photoconductive belt to record the latent images which correspond to the signals transmitted from IPS 12. One latent image is developed with cyan developer material. Another latent image is developed with magenta developer material,

and the third latent image is developed with yellow developer material. A black latent image may be developed in lieu of or in addition to other (colored) latent images. These developed images are transferred to a copy sheet in superimposed registration with one another to form a
5 multicolored image on the copy sheet. This multicolored image is then fused to the copy sheet forming a color copy.

With continued reference to Figure 1, printer or marking engine 18 is an electrophotographic printing machine. Photoconductive belt 20 of marking engine 18 is preferably made from a photoconductive
10 material. The photoconductive belt moves in the direction of arrow 22 to advance successive portions of the photoconductive surface sequentially through the various processing stations disposed about the path of movement thereof. Photoconductive belt 20 is entrained about rollers 23 and 26, tensioning roller 28, and drive roller 30. Drive
15 roller 30 is rotated by a motor 32 coupled thereto by suitable means such as a belt drive. As roller 30 rotates, it advances belt 20 in the direction of arrow 22.

Initially, a portion of photoconductive belt 20 passes through a charging station, indicated generally by the reference numeral 33. At
20 charging station 33, a corona generating device 34 charges photoconductive belt 20 to a relatively high, substantially uniform potential.

Next, the charged photoconductive surface is rotated to an exposure station, indicated generally by the reference numeral 35.
25 Exposure station 35 receives a modulated light beam corresponding to information derived by RIS 10 having multicolored original

document 38 positioned thereat. The modulated light beam impinges on the surface of photoconductive belt 20. The beam illuminates the charged portion of the photoconductive belt to form an electrostatic latent image. The photoconductive belt is exposed three or four times to record three or four latent images thereon. If a hi-fi color system is utilized, the photoconductive belt ^{will} be exposed for each primary color in the development system; i.e., in a hi-fi color system having the primary colors of cyan, magenta, yellow, orange, and black, the photoconductive belt will be exposed 5 times.

After the electrostatic latent images have been recorded on photoconductive belt 20, the belt advances such latent images to a development station, indicated generally by the reference numeral 39. The development station includes four individual developer units indicated by reference numerals 40, 42, 44 and 46. The developer units are of a type generally referred to in the art as "magnetic brush development units."

Typically, a magnetic brush development system employs a magnetizable developer material including magnetic carrier granules having toner particles adhering triboelectrically thereto. The developer material is continually brought through a directional flux field to form a brush of developer material. The developer material is constantly moving so as to continually provide the brush with fresh developer material. Development is achieved by bringing the brush of developer material into contact with the photoconductive surface. Developer units 40, 42, and 44, respectively, apply toner particles of a specific color which corresponds to the complement of the specific color

separated electrostatic latent image recorded on the photoconductive surface.

The color of each of the toner particles is adapted to absorb light within a preselected spectral region of the electromagnetic wave spectrum. For example, an electrostatic latent image formed by discharging the portions of charge on the photoconductive belt corresponding to the green regions of the original document will record the red and blue portions as areas of relatively high charge density on photoconductive belt 20, while the green areas will be reduced to a voltage level ineffective for development. The charged areas are then made visible by having developer unit 40 apply green absorbing (magenta) toner particles onto the electrostatic latent image recorded on photoconductive belt 20.

Similarly, a blue separation is developed by developer unit 42 with blue absorbing (yellow) toner particles, while the red separation is developed by developer unit 44 with red absorbing (cyan) toner particles. Developer unit 46 contains black toner particles and may be used to develop the electrostatic latent image formed from a black and white original document. Each of the developer units is moved into and out of an operative position. In the operative position, the magnetic brush is substantially adjacent the photoconductive belt, while in the nonoperative position, the magnetic brush is spaced therefrom. During development of each electrostatic latent image, only one developer unit is in the operative position, the remaining developer units are in the nonoperative position.

After development, the toner image is moved to a transfer station, indicated generally by the reference numeral 65. Transfer station 65 includes a transfer zone, generally indicated by reference numeral 64. In transfer zone 64, the toner image is transferred to a sheet of support material, such as plain paper amongst others. At transfer station 65, a sheet transport apparatus, indicated generally by the reference numeral 48, moves the sheet into contact with photoconductive belt 20. Sheet transport 48 has a pair of spaced belts 54 entrained about a pair of substantially cylindrical rollers 50 and 53. A sheet gripper (not shown in Figure 1) extends between belts 54 and moves in unison therewith.

A sheet 25 is advanced from a stack of sheets 56 disposed on a tray. A friction retard feeder 58 advances the uppermost sheet from stack 56 onto a pre-transfer transport 60. Transport 60 advances the sheet (not shown in Figure 1) to sheet transport 48. The sheet is advanced by transport 60 in synchronism with the movement of the sheet gripper. The sheet gripper then closes securing the sheet thereto for movement therewith in a recirculating path. The leading edge of the sheet (again, not shown in Figure 1) is secured releasably by the sheet gripper.

As belts 54 move in the direction of arrow 62, the sheet moves into contact with the photoconductive belt, in synchronism with the toner image developed thereon. In transfer zone 64, a corona generating device 66 sprays ions onto the backside of the sheet so as to charge the sheet to the proper magnitude and polarity for attracting the toner image from photoconductive belt 20 thereto. The sheet

remains secured to the sheet gripper so as to move in a recirculating path for three cycles. In this way, three or four different color toner images are transferred to the sheet in superimposed registration with one another.

5 One skilled in the art will appreciate that the sheet may move in a recirculating path for four cycles when under color removal (UCR) is used. Each of the electrostatic latent images recorded on the photoconductive surface is developed with the appropriately colored toner and transferred, in superimposed registration with one another,
10 to the sheet to form the multicolored copy of the colored original document. After the last transfer operation, the sheet transport system directs the sheet to a vacuum conveyor 68. Vacuum conveyor 68 transports the sheet, in the direction of arrow 70, to a fusing station, indicated generally by the reference numeral 71, where the transferred
15 toner image is permanently fused to the sheet. Thereafter, the sheet is advanced by a pair of rolls 76 to a catch tray 78 for subsequent removal therefrom by the machine operator.

The final processing station in the direction of movement of belt 20, as indicated by arrow 22, is a photoreceptor cleaning apparatus,
20 indicated generally by the reference numeral 73. A rotatably mounted fibrous brush 72 may be positioned in the cleaning station and maintained in contact with photoconductive belt 20 to remove residual toner particles remaining after the transfer operation. Thereafter, lamp 82 illuminates photoconductive belt 20 to remove any residual charge
25 remaining thereon prior to the start of the next successive cycle.

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a
a
As noted above, conventional object oriented rendering systems render based upon the object notwithstanding ~~the contents of the object, such as whether the object contains neutral image data or not.~~^a An example of such a system is illustrated in Figure 1⁷ wherein a triplet of data (color, colorspace, and object information) is fed into a rendering path circuit 105 which will process the triplet according to the object designation. After being processed the data is passed onto a rendering device 106 for rendering. By utilizing this conventional system to process and render both neutral image data and non-neutral image data, the conventional rendering system sacrifices color fidelity.

To avoid these problems with the conventional devices, the present invention, as illustrated in Figure 2, transforms the neutral color data prior to it being sent to the rendering path circuit 105. More specifically, object oriented image data is received by a neutral rendering transformation circuit 100 which parses the incoming image data into neutral image data and non-neutral image data. The parsed neutral image data has its color image data and colorspace data transformed, and the transformed neutral image data and the non-neutral image data are fed into an imaging system 105.

Thereafter, the processed neutral color image data and the processed non-neutral color image data are fed into a rendering device 106 which converts the image data into an image which can be readily seen by a user. This rendering device may be either a display screen or a printing system.

Figure 3 illustrates the process utilized by the system illustrated in Figure 2. More specifically, as illustrated in Figure 3, step S1

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PB
receives image data in the form of image data triplets. An image data triplet consists of color image data, data indicating the color space, and data indicating the object type of the incoming image data. The incoming stream of color image data triplets (~~color image data, color space data, and object type data~~) are parsed at step S2 based upon the feature set associated with the rendering of the object. These incoming triplets are parsed into two sets of triplets at step S2. One set of triplets contains neutral colors and the other set of triplets contain non-neutral colors.

10 The triplets containing neutral image data have their color and colorspace information transformed at step S7. Thereafter, the transformed neutral image data and non-neutral image data are processed utilizing an object dependent device pathway in step S8.

15 In one embodiment of the present invention, as illustrated in Figure 4, the neutral color image data is further parsed into separate components. More specifically, as illustrated in Figure 4, a neutral/non-neutral parser circuit 100 receives an incoming stream of triplets which contain color image data, color space data, and object ~~type data~~ ^{information}. These triplets are parsed by the neutral/non-neutral parser

20 circuit 100 into two sets of triplets wherein one set of triplets contain neutral colors and the other set of triplets contain non-neutral colors. The set containing non-neutral colors is processed in the ~~usual~~ conventional fashion by an imaging system 105.

a
On the other hand, the triplets containing the neutral color image data triplets (neutral color image data, color space data, and object type data) are fed into a neutral parser circuit 101 which further parses

the incoming triplets into three separate sets of triplets based on the feature set.

One triplet set contains black triplets, a second triplet set contains grey triplets, and a third triplet set contains white triplets wherein each triplet contains color image data, color space data, and object type data. The resulting parsed triplets are then processed independently according to the feature set to transform their color image data and colorspace data.

More specifically, the triplets corresponding to the black image data are processed by a black processor 102; whereas the triplets having the grey image data are processed by a grey processor 103. Lastly, the triplets containing the white image data are processed by a white processor 104. The black processor 102, grey processor 103, and white processor 104 are contained within a neutral processing circuit 110. The processed neutral data is then fed into the imaging system 105 where this neutral image data will be processed by the rest of the system in the conventional manner to produce an output that meets the proper neutral rendering requirements.

Figure 5 illustrates a method for rendering of neutral color image data according to the concepts of the present invention and the system illustrated in Figure 4. As illustrated in Figure 5, step S1 receives image data in the form of triplets. This image data is parsed into neutral color image data and non-neutral color image data at step S2. The parsed neutral color image data is then parsed into black image data, grey image data, and white image data at step S3. The black image data, grey image data, and white color image data triplets

are then each processed individually at step S4. The process black image data, grey image data, and white image data triplets are then processed again in an imaging system along with the non-neutral image data at step S5.

5 An example of a software implementation of the above described method is set forth in Table 2 below. This table sets forth an example of software code, as implemented in PostScript™ and C, which carries out the functions described above. Although the process of the present invention has been implemented in software, it
10 can also be readily implemented in hardware.

Table 2

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*

15 * Contains proprietary information of
* Xerox Corporation and is protected under the copyright
* laws as an unpublished work.
*

20 PUBLIC procedure neutralRenderingInit() ;
PUBLIC procedure preNeutralRendering() ;
PUBLIC procedure graphicPostNeutralRendering() ;
PUBLIC procedure textPostNeutralRendering() ;
PUBLIC procedure preStringwidth() ;
25 PUBLIC procedure postStringwidth() ;

#include PACKAGE_SPECS
#include CUSTOMOPS
#include UTIL
30 #include "neutralRendering.h"

/*****/
#define RETURN_BOOL

```
#define PATTERN_PAINT_TYPE_1
#define TRUE 1
#define FALSE 0
#define CURRENTPOINT 40
5 #define MOVETO 107
#define CURRENTCOLOR 213
#define CURRENTCOLORSPACE 214
#define SETCOLOR 221
#define SETCOLORSPACE 222
10 #define CURRENTOVERPRINT 433
#define SETOVERPRINT 450
#define DEVICE_CIEBASEDABC 471
#define DEVICE_CIEBASEDDEFG 478 /* CIEBasedDEFG isn't
defined by Adobe */
15 #define DEVICE_CIEBASEDA 470
#define DEVICE_CMYK 472
#define DEVICE_GREY 473
#define DEVICE_RGB 474
#define PATTERN 476
20 #define GSAVE 78
#define GRESTORE 77
#define POP 117
#define SETGREY 150
#define RGB_BLACK 0
25 #define RGB_WHITE 765 /* 3*255 */
#define SET_BLACK_OVERPRINT " gsave true setoverprint [
/Separation /Black /DeviceCMYK {pop 0 0 0 1} ] setcolorspace 1
setcolor"
#define SET_BLACK_OVERPRINT2 " {true setoverprint [ /Separation
30 /Black /DeviceCMYK {pop 0 0 0 1} ] setcolorspace 1 setcolor}"
#define SET_BLACK_OVERPRINT3 " {X_SetBlackOverPrint}"
#define SET_GREY " {XSD_setgrey}"

/*****
35 *****/
PRIVATE boolean gs_modified;
PRIVATE Int32 neutralNestingCount;
#ifdef RETURN_BOOL
PRIVATE boolean return_status;
```

#endif

/*

******/

5 PRIVATE procedure setBlackOverprint() {
 gs_modified = TRUE;
 #ifdef RETURN_BOOL
 PSExecuteString(SET_BLACK_OVERPRINT);
 #else
10 PSExecuteString(SET_BLACK_OVERPRINT2);
 return_status = TRUE;
 #endif
}

15 /*

******/
PRIVATE procedure setGrey(real greyValue) {
 gs_modified = TRUE;
 #ifdef RETURN_BOOL
20 PSExecuteOperator (GSAVE);
 PSPushReal(greyValue);
 PSExecuteOperator (SETGREY);
 #else
 PSPushReal(greyValue);
25 PSExecuteString(SET_GREY);
 return_status = TRUE;
 #endif
}

30 /*

******/
PRIVATE procedure processRGB() {
 boolean trueGrey;
 boolean blackOverPrint;
35 boolean processBlack;
 Int32 component1, component2, component3, colorTemp, colorDiff;
 real realComponent1;
 realComponent1 = PSPopReal();
 component1 = realComponent1 * 255;

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```
component2 = PSCPopReal() * 255;
component3 = PSCPopReal() * 255;
trueGrey = PSCPopBoolean();
blackOverPrint = PSCPopBoolean();
5 processBlack = PSCPopBoolean();
colorTemp = component1 + component2 + component3;
if ( colorTemp == RGB_BLACK ) {
    if (blackOverPrint) {
        setBlackOverprint();
10    } else if (trueGrey && !processBlack) {
        setGrey( 0.0 );
    }
    } else if ( (colorTemp == RGB_WHITE) && trueGrey ) {
        setGrey(1.0);
15    } else if (trueGrey) {
        #if 0
            colorDiff = component1 - component2;
            colorTemp = os_abs(colorDiff);
            colorDiff = component1 - component3;
20            colorTemp += os_abs(colorDiff);
            colorDiff = component2 - component3;
            colorTemp += os_abs(colorDiff);
            if (colorTemp <= 3) {
                #else
25                if ( (component1 == component2) && (component1 ==
component3) ) {
                    #endif
                        setGrey( realComponent1 );
                    }
30    }
}

/*****
*****/

35 PRIVATE procedure processGrey( ) {
    boolean blackOverPrint;
    real realComponent1;
    realComponent1 = PSCPopReal();
    blackOverPrint = PSCPopBoolean();
```

```
PSExecuteOperator(POP); /* processBlack */  
if ( blackOverPrint && (realComponent1 == 0.0) ) {  
    setBlackOverprint();  
}
```

5 }

```
/*  
*****  
******/
```

```
PRIVATE procedure processCMYK( ) {
```

```
10  boolean trueGrey;  
    boolean blackOverPrint;  
    boolean processBlack;  
    Int32 yellow, magenta, cyan, black, colorTemp, colorDiff;  
    black = PSPopReal() * 255;  
15  yellow = PSPopReal() * 255;  
    magenta = PSPopReal() * 255;  
    cyan = PSPopReal() * 255;  
    trueGrey = PSPopBoolean();  
    blackOverPrint = PSPopBoolean();  
20  processBlack = PSPopBoolean();  
    #if 0  
        colorDiff = yellow - magenta;  
        colorTemp = os_abs(colorDiff);  
        colorDiff = yellow - cyan;  
25  colorTemp += os_abs(colorDiff);  
        colorDiff = magenta - cyan;  
        colorTemp += os_abs(colorDiff);  
        if ( colorTemp <= 3 ) {  
    #else  
30  if ( (yellow == magenta) && (yellow == cyan) ) {  
    #endif  
        /* neutral */  
        if ( blackOverPrint && (black==255) ){  
            setBlackOverprint();  
35  } else if ( trueGrey ) {  
            if ( (black==0) && (cyan==0) && (magenta==0) && (yellow==0) ) {  
                /* white */  
                setGrey( 1.0 );  
            } else {
```



```

colorTemp = 255 - (black + cyan);
if (colorTemp > 0) {
    /* grey */
    setGrey((real)colorTemp/255);
5   } else {
    /* black */
    if (!processBlack) setGrey ( 0.0 );
    }
    }
10  }
    }

}

15  /*****
    *****/
PRIVATE procedure processCIEBasedABC( ) {
    PObject rangeABC;
    PSPopTempObject( arrayType, &rangeABC );
20  if ( (rangeABC.val.arrayval[0].val.ival == 0) &&
        (rangeABC.val.arrayval[1].val.ival == 1) &&
        (rangeABC.val.arrayval[2].val.ival == 0) &&
        (rangeABC.val.arrayval[3].val.ival == 1) &&
        (rangeABC.val.arrayval[4].val.ival == 0) &&
25  (rangeABC.val.arrayval[5].val.ival == 1) ) {
    processRGB();
    } else {
        PSEecuteOperator(POP); /* C */
        PSEecuteOperator(POP); /* B */
30  PSEecuteOperator(POP); /* A */
        PSEecuteOperator(POP); /* trueGrey */
        PSEecuteOperator(POP); /* blackOverPrint */
        PSEecuteOperator(POP); /* processBlack */
    }
35 }

/*****
*****/
PRIVATE procedure processCIEBasedDEFG( ) {

```

```
PSObject rangeDEFG;
PSPopTempObject( arrayType, &rangeDEFG );
if ( (rangeDEFG.val.arrayval[0].val.ival == 0) &&
    (rangeDEFG.val.arrayval[1].val.ival == 1) &&
5    (rangeDEFG.val.arrayval[2].val.ival == 0) &&
    (rangeDEFG.val.arrayval[3].val.ival == 1) &&
    (rangeDEFG.val.arrayval[4].val.ival == 0) &&
    (rangeDEFG.val.arrayval[5].val.ival == 1) &&
    (rangeDEFG.val.arrayval[6].val.ival == 0) &&
10    (rangeDEFG.val.arrayval[7].val.ival == 1) ) {
    processCMYK();
} else {
    PSExecuteOperator(POP); /* G */
    PSExecuteOperator(POP); /* F */
15    PSExecuteOperator(POP); /* E */
    PSExecuteOperator(POP); /* D */
    PSExecuteOperator(POP); /* trueGrey */
    PSExecuteOperator(POP); /* blackOverPrint */
    PSExecuteOperator(POP); /* processBlack */
20 }
}

/*****
*****/
25 PRIVATE procedure processCIEBasedA( ) {
    PSObject rangeA;
    boolean blackOverPrint;
    boolean trueGrey;
    real    realComponent1;
30    PSPopTempObject( arrayType, &rangeA );
    if ( (rangeA.val.arrayval[0].val.ival == 0) &&
        (rangeA.val.arrayval[1].val.ival == 1) ) {
        realComponent1 = PSPopReal();
        trueGrey = PSPopBoolean();
35    blackOverPrint = PSPopBoolean();
        PSExecuteOperator(POP); /* processBlack */
        if ( blackOverPrint && (realComponent1 == 0.0) ) {
            setBlackOverprint();
        } else if (trueGrey) {
```

```
    setGrey (realComponent1);
  }
  } else {
    PSExecuteOperator(POP); /* A */
5    PSExecuteOperator(POP); /* trueGrey */
    PSExecuteOperator(POP); /* blackOverPrint */
    PSExecuteOperator(POP); /* processBlack */

10  }
  }
  /*****
  *****/
  PRIVATE procedure processPATTERN( ) {
15    integer PaintType;
    PaintType = PSPopInteger();
    PSExecuteOperator(POP); /* blackOverPrint */
    PSExecuteOperator(POP); /* processBlack */
    #ifdef PATTERN_PAINT_TYPE_1
20    if ((PaintType == 1) && (neutralNestingCount == 1)) {
        neutralNestingCount=0;
    }
    #endif
  }

25  /*****
  *****/
  PUBLIC procedure neutralRenderingInit() {
    gs_modified = FALSE;
30    neutralNestingCount = 0;
  }

  /*****
  *****/
35  PUBLIC procedure preNeutralRendering() {
    Int32  colorspaceID;
    colorspaceID = PSPopInteger();
    #ifdef RETURN_BOOL
    return_status = FALSE;
```

```
#endif
neutralNestingCount++;
if (neutralNestingCount > 1) {
    /* remove parameters from the stack */
5   switch (colorspaceID) {
        case DEVICE_RGB:
            PSExecuteOperator(POP); /* blue */
            PSExecuteOperator(POP); /* green */
            PSExecuteOperator(POP); /* red */
10        PSExecuteOperator(POP); /* trueGrey */
            break;
        case DEVICE_CMYK:
            PSExecuteOperator(POP); /* black */
            PSExecuteOperator(POP); /* yellow */
15        PSExecuteOperator(POP); /* magenta */
            PSExecuteOperator(POP); /* cyan */
            PSExecuteOperator(POP); /* trueGrey */
            break;
        case DEVICE_GREY:
20        PSExecuteOperator(POP); /* grey */
            /* trueGrey not sent */
            break;
        case DEVICE_CIEBASEDABC:
            PSExecuteOperator(POP); /* range array */
25        PSExecuteOperator(POP); /* C */
            PSExecuteOperator(POP); /* B */
            PSExecuteOperator(POP); /* A */
            PSExecuteOperator(POP); /* trueGrey */
            break;
30        case DEVICE_CIEBASEDDEFG:
            PSExecuteOperator(POP); /* range array */
            PSExecuteOperator(POP); /* G */
            PSExecuteOperator(POP); /* F */
            PSExecuteOperator(POP); /* E */
35        PSExecuteOperator(POP); /* D */
            PSExecuteOperator(POP); /* trueGrey */
            break;
        case DEVICE_CIEBASEDA:
            PSExecuteOperator(POP); /* range array */
    }
```

```
PSExecuteOperator(POP); /* A */
PSExecuteOperator(POP); /* trueGrey */
break;
case PATTERN:
5   PSExecuteOperator(POP); /* PaintType */
    /* trueGrey not sent */
    break;
}

10  PSExecuteOperator(POP); /* processBlack */
    PSExecuteOperator(POP); /* blackOverPrint */
} else {
    switch (colorspaceID) {
    case DEVICE_RGB:
15     processRGB();
        break;
    case DEVICE_GREY:
        processGrey();
        break;
20     case DEVICE_CMYK:
        processCMYK();
        break;
    case DEVICE_CIEBASEDABC:
        processCIEBasedABC();
25     break;
    case DEVICE_CIEBASEDDEFG:
        processCIEBasedDEFG();
        break;
    case DEVICE_CIEBASEDA:
30     processCIEBasedA();
        break;
    case PATTERN:
        processPATTERN();
        break;
35     default:
        PSExecuteOperator(POP); /* processBlack */
        PSExecuteOperator(POP); /* BlackOverprint */
        break;
    }
```

```

    }
    #ifdef RETURN_BOOL
        PSPushBoolean(return_status);
    #endif
5   }

    /*****
    *****/
    PUBLIC procedure graphicPostNeutralRendering() {
10  #ifdef RETURN_BOOL
        boolean status = FALSE;
    #endif
        neutralNestingCount --;
        if ( (neutralNestingCount == 0) && gs_modified ) {
15  gs_modified = FALSE;
    #ifndef RETURN_BOOL
        PSExecuteOperator( GRESTORE );
    #else
        status = TRUE;
20  #endif
    }
    #ifdef PATTERN_PAINT_TYPE_1
        else if (neutralNestingCount < 0) {
            neutralNestingCount=0;
25  }
    #endif
    #ifdef RETURN_BOOL
        PSPushBoolean(status);
    #endif
30  }

    /*****
    *****/
    PUBLIC procedure textPostNeutralRendering() {
35  #ifdef RETURN_BOOL
        boolean status = FALSE;
    #endif
        neutralNestingCount --;
        if ( (neutralNestingCount == 0) && (gs_modified) ){
```

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```
gs_modified = FALSE;
#ifdef RETURN_BOOL
    PSExecuteOperator( CURRENTPOINT );
    PSExecuteOperator( GRESTORE );
5    PSExecuteOperator( MOVETO );
#else
    status = TRUE;
#endif

10 }
#ifdef PATTERN_PAINT_TYPE_1
    else if (neutralNestingCount < 0) {
        neutralNestingCount=0;
    }
15 #endif
#ifdef RETURN_BOOL
    PSPushBoolean(status);
#endif
}

20
/*****
*****/
PUBLIC procedure preStringwidth() {
    neutralNestingCount++;
25 }

/*****
*****/
PUBLIC procedure postStringwidth() {
30     neutralNestingCount--;
}
```

a The neutral rendering system and method described above
avoids the problems associated ^{with} systems that perform expert color
35 adjustments to adjust various color characteristics, such as lightness,
contrast, chroma, color balance, etc. For example, an expert control

system may be programmed so that the neutrals for certain object types, such as text and graphic, are to remain unaltered by the expert controls. The neutral rendering system of the present invention parses out and processes the neutral color, colorspace and object type
5 triplets in a path of the system that is not affected by the expert controls.

In addition, the present invention also provides further advantages by utilizing an object oriented rendering system that classifies objects into object types and object sub-types. A more
10 detailed explanation of this system will be set forth below in the description of Figures 6 and 7.

As discussed above, object oriented rendering systems optimize rendering based upon partitioning of objects into types, such as bitmap, text, and graphic. This tagging method has certain limitations,
15 which can be overcome by sub-typing. The object type/sub-type tagging method allows for common rendering characteristics to be identified by the object type and rendering fine-tuning to be performed based upon the sub-type.

As an example, sweeps or gradient fills can be considered a
20 sub-type of a graphic object type. Certain rendering characteristics, such as color rendering, may be shared with the graphic object type, while other characteristics, such as halftoning, may be optimized for sweeps. In a preferred embodiment of the present invention, the object type/sub-type combinations are as follows:

<u>Object Type</u>	<u>Object Sub-Type</u>	<u>Example</u>
Bitmap	Image	image of a real world scene
Bitmap	Graphic	scanned corporate logo
5 Graphic	Fill	graphic area fills
Graphic	Line	
Graphic	Sweep	gradient fills
Text	Halftoned	
Text	Solid	

10

To further explain this concept, it will be assumed that there are three object types (Bitmap, Graphic and Text) and two sub-types for
15 graphic objects (lines and fills). Line and fill sub-types share many common rendering characteristics as members of the graphic object type, but differ with respect to neutral rendering. Black lines are rendered as single component, rather than process, to reduce misregistration and imperfect color balance artifacts. Black fills are
20 rendered as process black rather than single component blacks in order to reduce differential gloss effects that are evident in color and black sweeps and to reduce black fill "dropouts" due to gloss differences with filled colored areas.

~~Figure 6 illustrates a process for rendering neutral color image data based on object types and object sub-types classification concepts discussed above. As illustrated in Figure 6, the process~~

[illegible][illegible][illegible][illegible]

which further parses the incoming quads into three separate sets of quads based on the feature set.

One quad set contains black color quads, a second quad set contains grey color quads, and a third quad set contains white color quads wherein each quad contains color image data, color space data, object type data, and object sub-type data. The resulting parsed quads are then processed independently according to the feature set. More specifically, the quads corresponding to the black color image data are processed by a black processor 102; whereas the quads having the grey color image data are processed by a grey processor 103.

Lastly, the quads containing the white color image data are processed by a white processor 104. The black processor 102, grey processor 103, and white processor 104 are contained within a neutral color processing circuit 110. The processed neutral color data is then fed into the imaging system 105 where this neutral color image data will be processed by the rest of the system in the conventional manner to produce an output that meets the proper neutral rendering requirements.

As described above, the present invention provides a system and method for obtaining a desired neutral rendering in a fashion that does not sacrifice color fidelity and is independent of the effects of print drivers and applications on neutral rendering. The present invention also allows for object oriented neutral rendering, can be used to meet the neutral rendering requirements of systems that perform expert color adjustments, and provides a frame work for

features that affect neutral rendering. Furthermore, the present invention provides a system and method which can optimize object oriented rendering by utilizing a object type and object sub-type tagging method.

5 Although the present invention has been described in detail above, various modifications can be implemented without departing from the spirit of the present invention. For example, the preferred embodiment of the present invention has been described with respect to a printing system; however, this method is readily implemented in a display system.

10 Moreover, the present invention is not limited to a xerographic system but is independent of the output system and can be readily used in an inkjet environment. It is also applicable to hi-fi color systems.

15 While the present invention has been described with reference to various embodiments disclosed herein before, it is not to be combined to the detail set forth above, but is intended to cover such modifications or changes as made within the scope of the attached claims.